

LAB: Linear Alkyl Benzene

Detergent linear alkylbenzene (LAB) is manufactured using linear hydrocarbons in the C₁₀ – C₁₃ range.

Methods of Manufacture

- A. Chloroparaffin/ AlCl₃ – n-alkyl chloroparaffins are reacted with benzene in the presence of AlCl₃ (aluminum chloride) catalyst in preparing the LAB alkylates. The alkylate is high in 2-phenyl (25 – 35%) and high in dialkyltetralin (6 – 10%) content.
- B. Olefin/HF – Primary and secondary olefins are reacted with benzene in the presence of HF (hydrofluoric acid) catalyst in preparing the LAB. The alkylate is low in 2-phenyl isomer (12 – 22%) and low in dialkyltetralin (< 1%) content.
- C. Olefin/AlCl₃ – Alpha olefins are reacted with benzene in the presence of AlCl₃ catalyst in preparing the LAB. The alkylate is high in 2-phenyl isomer content (25 – 35%) and low in dialkyltetralin (< 1%) content.
- D. Olefin/ Solid Catalyst - Alpha olefins are reacted with benzene in the presence of solid catalyst in preparing the LAB. The alkylate is high in 2-phenyl isomer content (25 – 35%) and low in dialkyltetralin (< 1%) content.

Effects on Performance

- A. Average Chain Length – As the average chain length increases, the water solubility decreases. C_{11,2} LAB is better for light duty applications. C_{12,8} LAB is used in heavy duty applications, e.g. home laundry formulations.
- B. High 2-Phenyl/Tetralin – Good for formulations which need good water solubility, clarity of the solution, and low viscosity.
- C. High 2-Phenyl/Low Tetralin – Same as “B” but with very slightly higher viscosity.
- D. Low 2-Phenyl/Tetralin – Good for formulations where decreased water solubility is desired or for heavy duty I & I applications.

LAS: Linear Alkylbenzene Sulfonic Acid

Reacting LAB with oleum or sulfur trioxide produces linear alkylbenzene sulfonic acid.

Pilot's Methods of Manufacture

- A. SO₃/SO₂ Continuous Process: LAB is sulfonated by reaction with SO₃ (sulfur trioxide) in the presence of SO₂ (sulfur dioxide). The SO₂ acts as both a refrigerant and diluent to moderate the sulfonation reaction. The SO₂ is removed after the sulfonation is complete.

- B. Continuous Air/SO₃ Sulfonation: LAB is sulfonated by reaction with SO₃ (sulfur trioxide) in the presence of a steam of dry air. The airflow is controlled to maintain the proper air/SO₃ ratio and to moderate the reaction temperature.

Pilot's LAS Type Products

- B. High 2-Phenyl: Calsoft LAS-99, Calsoft F-90, Calsoft L-60, Calsoft L-50, and Calsoft L-40 where the end products have good water solubility, form clear solutions and can easily build viscosity.
- C. Low 2-Phenyl: Calsoft LPS-99, Calsoft P-85, and Calsoft TSA-99. The end use products have lower water solubility, do not form clear solution at the 30% level, and are used for heavy-duty applications where oily soil removal is enhanced. Note: Imported LAS is very likely low 2-phenyl and will therefore perform differently compared to LAS-99.

Neutralization

LAS is neutralized by adding sulfonic acid into a caustic solution while mixing. Good mixing is required to adequately disperse and neutralize the LAS. In preparing 1000 lbs. of 60% NaLAS, water (~300 lbs.) and 50% NaOH (~150 lbs.) are mixed together in preparing a 17% NaOH solution. LAS-99 (~550 lbs.) is slowly added into the caustic solution in a stainless steel vessel while mixing. The final product's pH should be in the 7.0 – 8.5 range. If the pH drops below 7.0, high levels of iron can be introduced into the NaLAS product causing the material to take on an orange colored appearance. On dilution or blending with other surfactants at reduced concentrations, the iron salts tend to fall out of solution forming an orange precipitate. At very low pH values in the 2 – 5 range, the NaLAS solution will have a pungent sulfide odor because of corrosion of iron or steel.

Composition:

Pilot's Calsoft LAS-99 and LPS-99 are high in active (97% minimum) and low in free oil and sulfuric acid (typically <1.5% each). The sulfonic acid color is low, less than 50 Klett (20mm, 5% soln.).

Pilot's Calsoft TSA-99 (tridecylbenzene sulfonic acid) is high in active (97% minimum) and has free oil and sulfuric acid contents < 1.5%. The sulfonic acid color is typically < 50 Klett.

Applications:

- A. Neutral Salts: The sodium, calcium, potassium, ammonium, diethanolamine triethanolamine, and mono isopropylamine salts can be prepared from LAS-99, LPS-99, or TSA-99.
- B. Laundry Detergents: LAS is most often used in combination with other surfactants such as alcohol sulfate, alcohol ether sulfate, alcohol ethoxylate, or soap. Mixed active products provide greater versatility with respect to washing conditions. The addition of alcohol ethoxylate and/or fatty acid soap also helps limit foaming. This is important in front-loading washers and industrial cleaning equipment.
- C. Hand-Dishwashing: LAS is commonly used in combination with alcohol ether sulfate (AES). Both LAS and AES are excellent foamers, but blends (particularly in the 4:1 LAS: AES range), provide more stable, soil-tolerant foam. Consequently, most hand dishwashing detergents that contain LAS also contain AES.
- D. Hard-Surface Cleaners: LAS is used when foaming, particulate detergency and powder properties are important.
- E. Shampoos or Liquid Hand Soaps: LAS is not normally used because LAS may be somewhat harsh at the high surfactant concentrations typical of these types of products.